Navigating the Future: Enhancing E-Scooter Traffic Management through Governance and Regulation

GeoSence
The project GeoSence elaborates on geofencing solutions aiming at improving urban traffic management and planning.
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Summary

The GeoSence project, which is part of the Joint Programme Initiative (JPI) Urban Europe, aims to provide an overview of the current state of the art and showcase practical applications of geofencing. The project partners come from Germany, Norway, Sweden, and the UK and is funded by the European Union's Horizon 2020 programme under the ERA-NET Cofound Urban Accessibility and Connectivity. Geofencing is defined as a virtual boundary in a specific geographical location, either fixed or dynamic.

The GeoSence project focuses on improving urban transport by using geofencing methods for traffic planning and management. In this report, we examine the policies that support these solutions, while also identifying barriers and opportunities for smarter regulation. Our research focuses primarily on Munich, looking at issues such as parking, restricted areas, and data collection from e-scooter operators. Many European cities are struggling with problems associated with e-scooters, such as dangerous driving and inappropriate parking. In Munich, geofencing technology has been tested as a solution to address these issues and improve road safety, particularly for pedestrians.

The city's main objective was to improve road safety for all road users, especially pedestrians. By reducing inappropriate parking, the city also expected to increase public acceptance of e-scooters. As a first step in dealing with this new form of mobility, the city's initial response included the creation of 30 dedicated parking zones in 2020 and 2021 and a voluntary commitment with mobility service providers to regulate this new form of mobility. By joining the GeoSence project, the city wanted to explore geofencing as a solution to the persistent road safety problems caused mainly by poorly parked e-scooters. With GeoSence, Munich was able to monitor and optimise the use of parking zones, improve parking and road safety, and prevent drunk driving. To define the case studies, the city collected data from e-scooter operators, including parking start and end times, vehicle types and GPS coordinates. This data was used to identify parking hotspots and plan further parking infrastructure, as well as to evaluate the use of existing parking infrastructure.

Three different case studies were conducted to evaluate new parking policies based on geofencing. The first case study focused on parking e-scooters in 43 dedicated zones in Munich's old town. The second focused on the optimisation of parking in 30 existing zones outside the historic centre of the old town of Munich. Finally, the third case study introduced a new parking concept for the Oktoberfest events in 2022 and 2023. This temporary concept included designated zones and time-based usage restrictions.

The results showed an increased concentration of e-scooters in the designated zones, improving the parking situation. Since GeoSence has demonstrated the success of the measures to improve the parking of e-scooters across the city, in November 2023 the City Council also mandated the Department of Mobility and the Department of Construction to create a citywide network of parking zones for shared micro-mobility services by 2026. This will build on the experience of the pilot concept for such parking facilities in the old town. In cooperation with mobility providers, no-parking zones of 100 metres will be set up around each parking space. The municipality is also working on a concept to manage the use of electric scooters during major events. To monitor compliance, geofencing tools will continue to collect data, while the results of GeoSence will be used to develop smart policies. The city's own MDAS project will

provide dedicated monitoring data and analysis to make the implementation of the new parking zones and policies more effective.

In the GeoSence project, the city of Munich combined contracts, public procurement, and regulation. The city entered into voluntary data-sharing agreements with operators, procured a data-sharing platform, and then used the data for better and smarter regulation. Better and smarter regulation is about moving away from a linear sequence of independent steps to a cycle of interlinked, mutually reinforcing steps. The idea is that regulation will be more effective and that citizens will have a better understanding of the rules and be more involved in creating new rules. We live in an ever-changing world, and with better and smarter regulation, our society will adapt more easily to new technologies. Rules also need to be future-proof and resilient, so that our society can adapt if necessary. Rules must also not hamper technological development and innovation. Better and smarter regulation also means making rules easier to understand and reducing administrative burdens for citizens and businesses.

To achieve regulatory coherence and coordination, it's important for countries and cities to share their experiences. E-scooter regulations vary across the EU, with Swedish cities having the ability to regulate speed while German cities do not. Munich is leading the way in improving regulatory practices through geofencing, which helps build capacity and competence. In the case study regarding the use of e-scooters during the Oktoberfest, Munich demonstrated its dynamic and responsive regulation by adapting rules to human behaviour and using a risk-based approach. Geofencing is proving to be essential in the development of adaptive and informed regulation. Effective regulation also requires collaboration with stakeholders and the collection of robust, high-quality data. Munich's transition to evidence-based and smart regulation involved building trust with e-scooter operators and investing in a data platform. The city recognises the importance of training staff and involving stakeholders in transparent regulatory processes. Future challenges include ensuring public participation in data-driven decision-making and continuously evaluating and improving the regulatory framework. Geofencing is therefore proving to be essential in developing adaptive and informed regulation.

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List of abbreviations

Abbreviation	Definition
EU	European Union
GDPR	General Data Protection Regulation
GNSS	Global Navigation Satellite Systems

Preface

This project report has been produced as part of the project GeoSence – Geofencing strategies for implementation in urban traffic management and planning. It is a Joint Programme Initiative (JPI) Urban Europe project funded by the European Union's Horizon 2020, under ERA-NET Cofound Urban Accessibility and Connectivity, and gathers project partners from Germany, Norway, Sweden, and the UK. The aim is to present the state of the art and describe use cases based on the project's working definition of geofencing, where a geofence is defined as a virtual geographically located boundary, statically or dynamically defined. The overall objective of GeoSence is also to design, test and evaluate new geofencing concepts and solutions for specific cases in cities, and to propose new ways of deploying different geofencing applications.

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We would like to emphasise that the views and opinions expressed in this report are those of the authors. Other parties or representatives may have a different analysis and come to different conclusions.

If you would like to know more about the pilot, the report and the GeoSence project, please contact kristina.andersson@ri.se or jan-hendrik.mueller@muenchen.de

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1. Introduction

1.1 Background

Societies face many challenges that require cooperation and innovative solutions. The focus of this report is on local governance, in this case cities, which should lead the way into the future. One of the challenges facing cities is transport and mobility management, which must strike a balance between improving accessibility and availability for users and addressing issues such as congestion, traffic accidents and incidents, health, and the environment. A long-term vision is needed, but the key for cities is to start the transformation step by step. Geofencing is a very good example of how cities are managing innovation and creating new innovative governance mechanisms and tools. The use of automated and connected vehicles is transforming urban mobility, leading to the development of new mobility services that offer better availability and lower operating costs. To meet the expected increase in demand, digital traffic control and planning tools need to be developed to ensure that public space is effectively coordinated. Geospatial data is crucial for this type of planning, and the city of Munich is exploring the use of geofencing for local traffic control and planning, which is a new area of work to be tested. For many, geofencing is simply the creation of virtual zones where vehicles can limit their speed or switch to electric operation. But this is only part of the story. Geofencing-based services could become powerful tools for continuous digital communication between, for example, cities, mobility providers and citizens, enabling better planning of mobility solutions and increasing compliance rates. The city has several important roles to play in this ecosystem:

- As road authorities, they are data providers and must ensure that the data entered, e.g. traffic rules, are correct and correspond to reality. This is crucial to be able to improve the digital maps needed for the development of geofencing services.
- As planners, they need tools that can provide information and communicate directly with relevant stakeholders, e.g. to improve the way mobility solutions are used in the city.
- As service providers, they can create demand by purchasing public transport, special transport, etc.

1.2 About the GeoSence project

GeoSence is a JPI Urban Europe project. It aims to co-design geofencing strategies in traffic management and urban planning. The project began in April 2021 and ended in June 2024. Three major cities - Stockholm, Munich, and Gothenburg - are involved in the project, each with their own use cases focusing mainly, but not exclusively, on the following:

Stockholm is reviewing its role as a data provider and wants to improve its governance structure to make better use of location-based data such as traffic monitoring data. This is an important prerequisite for the development of new geofencing-based services.

Munich shows how cities can successfully work with e-scooter operators to develop safer and more accessible micro-mobility solutions and regulations. The new regulations, tested as part of Munich's GeoSence project, aim to prevent e-scooters from being parked in places where they could obstruct or endanger pedestrians, especially those with reduced mobility. The city has data-sharing agreements with e-scooter operators; the data provides information, and a dashboard is used to monitor, create, and communicate geofencing zones.

Gothenburg demonstrates lower speed limits in vulnerable areas with its dedicated traffic services. The city is interested in understanding how geofencing services such as speed monitoring can help drivers and exploring how these services can be procured in the future. This is an important step for cities to show that they are taking proactive measures to improve road safety for road users such as school children and the elderly.

There are several project reports published within the project regarding geofencing and the different use cases.[1]

1.3 Purpose of the report

The GeoSence project as such is about "Geofencing strategies for implementation in urban traffic management and planning", where the objective is to define, trial and evaluate geofencing concepts and solutions for specific cases in cities, within the project and from other previous/ongoing geofencing initiatives, and to propose new ways of successfully deploying geofencing technologies. This report is a part of work package 3 in the GeoSence project. Work package 3 is about exploring new policies supporting the solutions and do an analysis of relevant policies, legislations, and processes in partner cities.

Munich is one of the partner cities in this project. In the GeoSence project, the city is exploring geofencing for better regulation of parking, no-go zones, and data collection with the consent of operators through agreements combined with public procurement. The main purpose of this report is therefore to explore the challenges and opportunities of better, smarter, and more intelligent regulation.

1.4 Methodology

In this report we combine a top-down approach with a more practical, bottom-up approach. The top-down approach consists of a theoretical study and the bottom-up approach consists of a pilot where we demonstrate data for governance regarding geofencing. The GeoSence project will focus on designing studies and collecting data in a way that isolates the impact of geofencing from other factors in each use case/pilot project. Isolating the impact of geofencing will identify the benefits of the project and avoid pitfalls in assessing impact when testing a range of interventions with multiple dimensions.

This report also follows a qualitative approach. The work has been carried out partly through literature studies (e.g., studies of relevant legislation, articles, reports, and publications), partly through dialogue with relevant actors in collaborative workshops and interviews. We have worked with an agile and iterative process where we have checked results and various solution proposals in several workshops to validate our results.

2. What is geofencing and how is it used?

The term geofencing is given different meaning in different contexts. The definition of geofencing in traffic management and planning in this report is consistent with the working definition in the GeoSence project, which is: *Creation of a geo-fence for monitoring, informing and controlling traffic (mobile objects/vehicles) located within, entering or exiting the geo-fence, using electronic communication technologies or pre-defined geo-fences embedded into the mobile*

[1]All the reports can be found at https://closer.lindholmen.se/geosence

objects/vehicles, where a geo-fence is defined as a virtual geographically located boundary, statically or dynamically defined.[2]

Note that geofencing is not a standardized technology. Also, geofencing does not consist of one technical solution. Instead, it can consist of different technical solutions together and the combinations of these can change over time. The potential applications of geofencing are very diverse and span different application areas and industries. Two key application possibilities play an important role in GeoSence and are described below, namely car traffic and shared micro-mobility.

In the research project GeoSUM (Geofencing for Smart Urban Mobility), new tools for more efficiency, safety and environmental compatibility in car traffic are being developed with the help of cooperative intelligent traffic systems and geofencing. This involves defining digital zones on a map, which are then transmitted directly to a vehicle and communicated to the driver via a Human Machine Interface (HMI). The project is investigating two different use cases for geofencing. One is about limiting the maximum speed of vehicles near schools, the other is about differentiating road tolls in environmental zones based on data transmitted by the vehicles, such as kilometres driven or fuel consumption.[3]

Geofencing for shared micro-mobility is already deployed in several EU and US cities and is steadily developing, especially in the application areas of e-scooters and bicycles.[4] Geofencing can be considered the state of the art for parking rental scooters and is part of the operating model for all providers. Vehicles are offered for short-term rental with variable pick-up and drop-off locations restricted by geofences. The most recent application is e-scooters, which are often used to complement existing local transport services and provide a viable first and last mile alternative.[5]

The city of Munich has imposed a driving and parking ban on e-scooters at certain times during the Oktoberfest in 2022 and 2023. To achieve this, vendors have committed to using geofencing to enforce the no driving, no renting, and no parking zones. This is a concrete example of how geofencing technology can be used to implement the temporary requirements of legislation.

3. Comparison of the legal situation of e-scooters in Germany and Sweden

3.1 E-Scooters in the European Union

In the absence of a uniform European framework, the requirements for e-scooters vary between the Member States of the European Union (EU). Some EU Member States have not regulated the use of e-scooters on public roads. Others have banned their use altogether. However, most EU Member States have adopted regulations. In most cases, a speed limit of 20 to 25 km/h is set for very small electric vehicles. There are also different approaches to permitted traffic areas. At the European level, the Type Approval Regulation (EU) No. 168/2013 has been in force since January

[2] Hansen et al., 2021
[3] Arnesen, Seter, Tveit & Bjerke, 2021
[4] Hansen et al., 2021
[5] Liazos, Iliopoulou, Kepaptsoglou & Bakogiannis, 2022

2016 for 2, 3 or 4-wheeled vehicles. It explicitly excludes self-balancing vehicles and vehicles without a seat from its scope.

When we talk about micro-mobility, we are referring to smaller electric vehicles such as e-scooters and Segways. These are grouped together under the generic term "micro electric vehicles". These vehicles are battery powered and therefore have no emissions. Many of these vehicles are also small in size and light in weight, making them foldable and portable. These characteristics allow users to take the vehicles with them, making them particularly valuable for linking different modes of transport and covering short distances (so-called "last mile mobility").

3.2 E-Scooters in Germany

Since the summer of 2019, e-scooters have been causing both excitement and frustration in Munich. There are concerns for pedestrians, who are at risk due to e-scooters being improperly parked. Despite this, e-scooters have become a popular mode of transport, with four companies (Bolt, Lime, Tier, and Voi) operating nearly 13,500 vehicles in Munich by 2023. The use of e-scooters on public roads in Germany is regulated by the 'Verordnung über die Teilnahme von Elektrokleinstfahrzeugen am Straßenverkehr (eKFV)'. This regulation creates the conditions for very small electric vehicles with a steering or stop bar to participate in road traffic from 15 June 2019. A list of general operating permits for very small electric vehicles, including these regulations, has also been published on the 'Kraftfahrt-Bundesamt' (KBA) website:

- In general, e-scooters must use cycle paths where they exist and can be used on public roads as long as they have the following features: steering or handlebars.
- 20 km/h is the maximum speed allowed and the vehicles must meet minimum road safety requirements (e.g. braking, lighting, handling, and electrical safety).
- The vehicle must also have a valid insurance sticker.
- E-scooters can be ridden from the age of 14. It is forbidden to carry people or objects on the footboard and to ride on pavements and pedestrian areas.

With the increasing popularity of sharing services such as e-scooters, conflicts over the use of public space and traffic obstructions have arisen. This also raises the question of whether sharing services such as e-scooters are common use or special use. To address this issue, most local authorities have used voluntary self-commitments, co-operation agreements or Letters of Intent (LoI) to mitigate the negative impacts, especially when it comes to regulating the parking of these vehicles. Some municipalities in Germany have therefore decided to treat these vehicles as a special use in order to be able to impose quotas and details on operators, which in turn has led to complaints and various court rulings. However, the regulation of e-scooter services by local authorities is handled differently in Germany. The operation of rental systems is generally not subject to licensing, public use of roads and public zones is not subject to licensing, but local special use statutes may apply. Municipalities in Germany must decide whether rental systems are considered public use without a permit or special use requiring a permit. However, the overall legal situation for parking e-scooters is still unclear.

The city of Munich considers this to be public use, as e-scooters can in principle be parked on pavements. Therefore, the parking of e-scooters on public property - just like bicycles - falls under public use according to Art. 14 Bayerisches Straßen- und Wegegesetz (BayStrWG) in conjunction with § 15 para. 3 Sondernutzungsrichtlinie (SoNuRiL) and therefore does not require

a permit. For this reason, the Munich Department of Mobility has already drawn up a voluntary declaration of commitment for cooperation with e-scooter operators for 2019, which includes parking regulations as the most important issue for the regulation of e-scooters from the city's point of view. For example, e-scooters must be parked so as not to obstruct pedestrians or other road users. However, as parking is mainly user-driven and requires good user behaviour, these regulations are very limited. Nevertheless, the existing voluntary self-commitment for providers of rental systems for e-scooters and other small electric vehicles was revised in April 2022 and the new version was signed by all e-scooter providers.

By further developing the self-commitment, the Department of Mobility is taking an important step from a safety and regulatory tool to a planning tool. This is in line with the shared mobility strategy adopted by the City Council on 19th January 2022. For example, no more than four e-scooters should be offered in a particular location. If they are parked on the pavement, at least 1.80 metres should remain available. They are not allowed in the pedestrian zone or in green areas. Providers must collect illegally parked e-scooters within 24 hours.

However, the key to the long-term acceptance of e-scooter rental systems in municipalities and their meaningful contribution to the transport offer is their regulation. In other German states, the legal situation is different and there have already been court decisions on this issue. In particular, cities in North Rhine-Westphalia, such as Cologne and Düsseldorf, have enacted special usage regulations for the operation of e-scooters. These enable the cities to issue legally binding regulations that rental companies must comply with in order to obtain an operating licence. Until 2020, station-independent sharing services were classified as public use without a permit (according to the 1982 ruling of the Federal Administrative Court). In 2020, the Higher Administrative Court of North Rhine-Westphalia (OVG NRW) classified the provision of bike sharing on public roads as a predominantly commercial use of road space. Other courts could follow suit and apply the same assessment to e-scooters. Legal certainty for local authorities is currently not improved by these rulings. Classification as a special use is subject to the general principles of road law, which may differ from state to state. However, in the light of recent court rulings in Münster and Bremen, and the classification of e-scooters as a 'special use', this seems to be a prerequisite for local authorities to be able to intervene in a sustainable way. A special use procedure would provide the legal means to reduce the number of vehicles and operators in the city. It could also require operators to record the number of parking zones in their digital systems.

Common use not subject to authorisation	**Special use subject to authorisation**
- Not subject to permission - Voluntary self-commitment of the providers - Requirements for city-friendly operation - Commitment to data exchange, parking requirements, fleet sizes, areas of operation, no-parking zones - Good communication between the authorities and the providers is essential.	- Requires approval - Lets municipalities use binding rules - Permits take into account limited availability of public road space and interference with public use - Fees, commercial and no-entry zones, limits, regulations on parking, response times, data reporting or a customer hotline can be non-controversial requirements.

- Sanctions for non-compliance, fees, or limitation of the fleet difficult (enforcement risk on the side of the authority)	- Selection process to be transparent and non-discriminatory, disclose selection criteria and provide for temporary special permits.

A possible way to implement a stricter regulation would be a tendering process and the selection of 2-3 e-scooter service providers, based on the classification of e-scooters as a special use in Munich. In the case of Munich, this would mean that in order to apply stricter regulation in a meaningful way, a needs assessment and regulatory concept should be developed and adopted by the city council, identifying the relevant road-related interests and setting out binding requirements, selection criteria, time limits and a time-limited procedure for resolving conflicts over the allocation of space between different applicants. In particular, the principles of equal treatment, transparency and non-discrimination must be respected. For reasons of confidence, any change in administrative practice should be announced in good time to allow all providers to prepare. However, it is unclear to what extent the objective data on the relevant aspects of road traffic, such as the number of accidents, complaints about parking obstructions, usage data or spatial differences in the urban area, can currently justify the definition of a tolerable level of disturbance and greater restrictions on the number of vehicles and/or providers in an alternative use concept. In this respect, legal risks remain in the case of possible lawsuits, e.g. from mobility service providers due to a refusal to offer or a limitation of the vehicle fleet, or from disability associations.

Even non-road aspects that sometimes attract political attention, such as sustainability, insurance cover for victims, logistics or working conditions, cannot be bindingly regulated in a permit, as the city of Munich understands the requirements for special road use. Similarly, the expectation of consistent monitoring by the City of Munich as the licensing authority for the permit ("The city has officially approved it, so it must also consistently ensure that the rules are observed") is a point that needs to be considered. Even a special use permit alone is unlikely to be a solution to the problem of user behaviour. Possible conditions only relate to the obligations of the provider as the recipient of the permit. Parking on pavements would continue to be allowed as a general rule, and only in situations where safety and traffic flow require it, by means of a condition in the permit. However, this would again require enforcement, which would be virtually impossible.

Overall, however, Munich faces an uncertain legal situation regarding the special use of e-scooters. Should the case go to court, the outcome is uncertain, especially given the lack of case law from Bavarian courts. All in all, the path of voluntary self-commitment combined with regular exchange with providers and the creation of additional segregated storage areas is still the right one for the time being. The experience from the exchange with the providers shows that it is possible to act quickly in a consensual exchange and that problems are rarely due to the actions of the providers themselves. In general, however, it would be desirable to have a national regulation for free-floating rental systems for e-scooters and other micro-mobility vehicles in the rental system. This would provide greater clarity and may help to improve understanding for users who use such vehicles across national borders.

3.3 E-Scooters in Sweden

The e-scooter is in Sweden classified as a bicycle, with a maximum of 20 km/h and a motor power of a maximum of 250 watts, otherwise it is a moped, or, if technical requirements are not met, it may not be used on public roads.

This means that basically the same traffic rules apply as for bicycles (both when driving and parking), that is:

- E-scooters should primarily be used on cycle paths or car roads, not sidewalks.
- On pedestrian streets and in pedestrian areas, only walking speed is allowed.
- E-scooters must not be parked in such a way that they obstruct traffic or pose a danger to other road users (same as for other vehicles). Parking is allowed for a maximum of 24 hours in a row on weekdays (in public place / on public road).
- The police are the traffic monitoring authority and monitors that traffic rules are complied with. But the municipality may move incorrectly parked bicycles that are considered to constitute a danger or obstacle in traffic.

However, special parking rules were introduced for e-scooters from September 2022. The new parking rules do not explicitly mention e-scooters (there was no new definition introduced for e-scooters in the legislation), but due to the wording of the parking rule it will essentially only affect e-scooters.

Although the same traffic rules apply as for bicycles, the users do not always handle e-scooters in the same way as bicycles. Municipalities in Sweden have far-reaching mandates to decide on local traffic regulations. However, municipalities cannot regulate the use of e-scooters with local traffic rules, as the legislation does not differentiate between bicycles and e-scooters. For instance, the municipality cannot ban e-scooters in an area where bicycles are allowed. That e-scooters cannot be separated from other bicycles in the traffic regulations has led to municipalities taking other measures to sort out certain problems associated with how these vehicles are used. For instance, municipalities often have ongoing dialogues and voluntary agreements with the operators of electric scooter rental services. Several municipalities have introduced permit systems for operators and some municipalities use public procurement.

3.4 Comparison

The big difference between Germany and Sweden is that the geofencing rules are not the same everywhere. In some European countries, the speed of vehicles is automatically reduced in traffic-calmed zones or in sensitive pedestrian areas (pedestrian precincts, green areas). This is possible in Sweden, but not in Germany. The technology makes it possible to block the scooter in areas where it is not allowed, or to limit the speed to 6 km/h in pedestrian areas. This is an important contribution to limiting illegal and dangerous use, for example in pedestrian areas. In Germany, this function is not permitted in the general operating licence, as current legislation prohibits remote speed control of e-scooters. For this reason, it is currently believed that the introduction of such a feature in Germany could have a negative impact on road safety. This is mainly due to the lack of positioning accuracy of the installed positioning systems in urban areas and the impairment of driving dynamics. For this reason, a possible speed reduction for e-scooters, for example in pedestrian zones, is currently not considered permissible in Germany, but will be reviewed in the course of further research. In this context, a common European standard for GPS accuracy and speed intervention would be desirable.

Both German and Swedish cities are trying to use data from e-scooters to improve regulation. Stockholm is also pushing for data-driven regulation of e-scooters. Like Munich, the city has data-sharing agreements with operators, has procured a mobility data and analytics platform, and is using the data to set up smarter regulations. The city has regulations on no parking zones, speed limit zones and recommended parking. Stockholm has similar challenges to Munich,

such as low accuracy of shared vehicle positioning, which makes it difficult to apply regulations in narrow zones.[6]

4. Innovative geofencing data governance pilot in Munich

Much of the success of e-scooter rental is due to the fact that they are free to use, meaning they can be picked up and dropped off almost anywhere. This has made them a very flexible, convenient, and time-saving mode of transport for their users. At the same time, it has caused inconvenience to others, particularly pedestrians, as suddenly parked vehicles have blocked access and right of way and created obstructions on the roadside (or worse, posed a danger to blind, partially sighted, or disabled people). Irregular parking, in addition to unsafe e-scooter riding, is a major challenge for cities and leads to public acceptance problems.[7] The city concluded that something needed to be done about the situation. As e-scooters were a new phenomenon, there was a lack of data, and at this stage the city based its decision on where the most complaints were reported and the observations of its own staff. So, in the first round, 30 e-scooter parking zones were created simply by counting complaints, to reduce problems with incorrectly parked e-scooters in 2020 and 2021. The city realised early on that in order to successfully expand the number of e-scooter parking zones to improve the parking situation, more data than just complaint tracking was needed. Therefore, in 2021, the city had access to a monitoring dashboard from another project (operator level data only). This allowed the city to understand what data it needed and what data was available. It soon became clear that due to GDPR issues, the city was not allowed to track driving data, only parking data. The next step was for the city to contact all e-scooter operators. The city asked if the operators were willing to voluntarily share data with the city. All operators said yes. By studying the data, the city was able to identify hot spots and decide on the second round of e-scooter parking, which was conducted as Case Study A during the GeoSence project.

The following data was provided free of charge by the operators every minute during business hours via a standardised interface. Outside business hours, this was done every 30 minutes. The operators also provided historical data.

Parking data:

- Start datum (dd.mm.yyyy hh:mm)
- End datum (dd.mm.yyyy hh:mm)
- Type of trip (rental/service/redistribution)
- Contact info start
- Coordinates end
- Vehicle ID
- Vehicle Type
- Battery charge level for each position information

Contact details from Operators:

- Number of vehicles (broken down by vehicle type)
- Map of the operating area (in a GIS format) operation area where are blind spots

[6] Stockholms stad (2022) Data driven regulation of Micromobility – A demonstration project with e-scooters providers in the city of Stockholm.
[7] Gössling, 2020

- Suggestion after trial: Number of rentals
- Suggestion by trial: Kilometres ridden
- Suggestion after trial: Hire time[8]

At the time, geofencing was also a new concept for the city. The city was interested in learning more about geofencing and joined the GeoSence project because cities and e-scooter operators had started to recognise the problem of irregular parking and were trying to improve the situation, either by informing users about proper parking, offering incentives for proper parking or penalties for improper parking, creating designated parking areas or installing special street furniture for e-scooter parking.[9] However, problems with improperly parked e-scooters persist, even though these measures have proven to be somewhat effective. The lack of technical solutions to easily and automatically monitor and enforce stricter parking regulations was therefore one of the current obstacles. Geofencing was seen as a technology that could make this possible.[10]

In Munich, the GeoSence project used geofencing technology to create designated parking, no-parking and no-go zones for e-scooters in the three case studies. The technology optimises the use of parking zones by defining no-parking zones around car parks. In addition, flexible and temporary no-stopping and no-riding zones can be set up for shared micro-mobility. The real-time transmission of vehicle location data enables the monitoring of these zones and thus the analysis of parking traffic metrics for shared mobility. For this purpose, a geofencing application was procured through a tender process to understand the given data and set up its own data while creating geofences with rules for parked e-scooters. In this case, the geofencing solution also supports networking between the city and shared mobility providers to digitally communicate local traffic rules to improve micro-mobility road safety.

5. Better, smarter, and more intelligent regulations

Better and smarter regulation is about moving away from a linear sequence of independent steps to a cycle of interlinked, mutually reinforcing steps. The idea is that regulation will be more effective and that citizens will have a better understanding of the rules and be more involved in creating new rules. We live in an ever-changing world, and with better and smarter regulation, our society will adapt more easily to new technologies. Rules also need to be future-proof and resilient, so that our society can adapt if necessary. And they must not hamper technological development and innovation. Better and smarter regulation is also about making rules easier to understand, reducing red tape for citizens and businesses, and being fit for purpose in the sense that it should not impose unnecessary burdens on citizens and businesses (proportionality).

The Organisation for Economic Co-operation and Development (OECD) published the 2012 *Council Recommendation on Regulatory Policy and Governance*, which provides guidance on better regulation. The document outlines several key principles to improve the quality and effectiveness of regulatory frameworks. Here is a summary of some of these principles:

[8] The above-mentioned data is provided by the provider in accordance with the Mobility Data Standard (MDS) in the currently valid form, see

[9] Klein et al., 2023

[10] Hansen et al., 2021

- **Commit to Regulatory Quality** - Governments should commit to regulatory quality to ensure regulations are effective, efficient, and serve the public interest.
- **Evidence-based Policy Making** - Policies should be developed based on rigorous evidence and analysis, including regulatory impact assessments (RIAs) to evaluate the potential effects of proposed regulations.
- **Open Government and Transparency** - Regulatory processes should be transparent, allowing for public consultation and participation. Stakeholders should have access to information and be able to contribute to regulatory decision-making.
- **Accountability** - Regulatory agencies and bodies should be held accountable for their actions. This includes clear roles and responsibilities, as well as mechanisms for review and evaluation of regulatory performance.
- **Coherence and Coordination** - Regulatory policies and practices should be coherent across different sectors and levels of government. Coordination among various regulatory authorities is essential to avoid conflicting regulations and ensure a unified approach.
- **Proportionality and Flexibility** - Regulations should be proportional to the issues they address and flexible enough to adapt to changing circumstances. Overly burdensome or rigid regulations can stifle innovation and economic growth.
- **Performance Measurement** - Continuous monitoring and evaluation of regulatory performance are crucial. Governments should establish frameworks for measuring the outcomes of regulations and making necessary adjustments.
- **Risk-based Regulation** - Regulatory actions should be based on an assessment of risks, focusing resources on the most significant issues while avoiding unnecessary regulation of low-risk activities.
- **Capacity Building** - Governments should invest in building the capacities of regulatory bodies and officials to develop and implement high-quality regulations effectively.
- **International Cooperation** - Regulatory policies should take into account international standards and practices, promoting cooperation and harmonization across borders to address global challenges and facilitate trade.
- **Regulatory Simplification and Burden Reduction** - Efforts should be made to simplify regulatory frameworks and reduce administrative burdens on businesses and citizens without compromising regulatory objectives.
- **Dynamic Adaptation** - Regulatory policies should be dynamic, allowing for regular reviews and updates to ensure they remain relevant and effective in changing environments.

Together, these principles aim to create a regulatory environment that is conducive to innovation, economic growth, and public confidence, while ensuring that regulations achieve their intended social, economic, and environmental objectives.

The process of better and smarter regulation is based on the following stages Initiate - Plan - Draft - Adopt - Implement - Monitor - Evaluate - Revise. These phases are sequential and circular and are supported by two fundamental pillars: the production of information to support evidence-based decision-making and stakeholder engagement. Information and data are essential throughout the cycle. Data and information are needed to support any decision based on evidence of expected and observed impacts. To generate information, the regulatory process uses an impact assessment tool that can be developed at two points in time: at the beginning of the cycle, providing ex-ante evidence of expected impacts, and at the end of the cycle, informing on ex-post results. Recent years have also seen the emergence of a debate on smarter

regulation. More intelligent regulations add new dimensions to the above phases and impact assessment tools, such as data analytics, AI and learning algorithms to support evidence of impact.

The OECD is running a project called Regulatory Policy 2.0 - the latest version of Better Regulation, which aims to unlock the potential of technology and innovation while ensuring public protection by 2030. The goal is more data-driven approaches for more effective and efficient rulemaking and regulatory delivery. In 2021, the OECD published *the Recommendation for Agile Regulatory Governance to Harness Innovation*. The document provides a framework for governments to create a regulatory environment that can effectively support and adapt to innovation. The principles outlined in the Recommendation focus on ensuring that regulations remain effective, efficient, and responsive to the rapid pace of technological and societal change. Here are some of the key principles:

- **Proportionality and Risk-Based Approaches** - Regulations should be proportionate to the risks they aim to mitigate. Risk-based approaches should be employed to ensure that regulatory responses are appropriate to the level of risk involved.
- **Innovation-Friendly Regulatory Environment** - Governments should create a regulatory environment that encourages innovation while safeguarding public interests. This includes removing unnecessary regulatory barriers and fostering an environment conducive to experimentation and innovation.
- **Collaboration and Stakeholder Engagement** - Engaging stakeholders, including businesses, academia, and the public, in the regulatory process is crucial. Collaboration helps in understanding the impacts of regulations and in identifying innovative solutions.
- **Regulatory Sandboxes and Pilot Programs** - Utilizing regulatory sandboxes and pilot programs allows for the testing of innovative products and services in a controlled environment. These tools help regulators and innovators understand potential impacts and refine regulations accordingly.
- **Dynamic and Responsive Regulation** - Regulations should be designed to be flexible and adaptable to changes in technology and market conditions. Regular reviews and updates to regulations ensure they remain relevant and effective.
- **Regulatory Coherence and Coordination** - Ensuring coherence and coordination among different regulatory bodies is important to avoid conflicting regulations and to streamline regulatory processes. This includes both domestic and international coordination to manage cross-border regulatory challenges.
- **Capacity Building and Regulatory Competence** - Building the capacity and competence of regulatory bodies is essential for effective regulatory governance. Training and resources should be provided to regulators to help them understand and manage emerging technologies and innovations.
- **Data-Driven and Evidence-Based Regulation** - Regulatory decisions should be based on robust data and evidence. The use of data analytics and other modern tools can enhance the effectiveness of regulatory actions.
- **Transparency and Accountability** - Transparency in the regulatory process helps build trust and ensures accountability. Clear communication about regulatory decisions and the rationale behind them is important for public trust.
- **Evaluation and Continuous Improvement** - Continuous evaluation of regulatory policies and practices is necessary to identify areas for improvement. Learning from both successes and failures helps in refining regulatory approaches.

Together, these principles aim to create a regulatory environment that is agile, supportive of innovation and able to meet the challenges posed by rapid technological advances, while protecting the public interest.

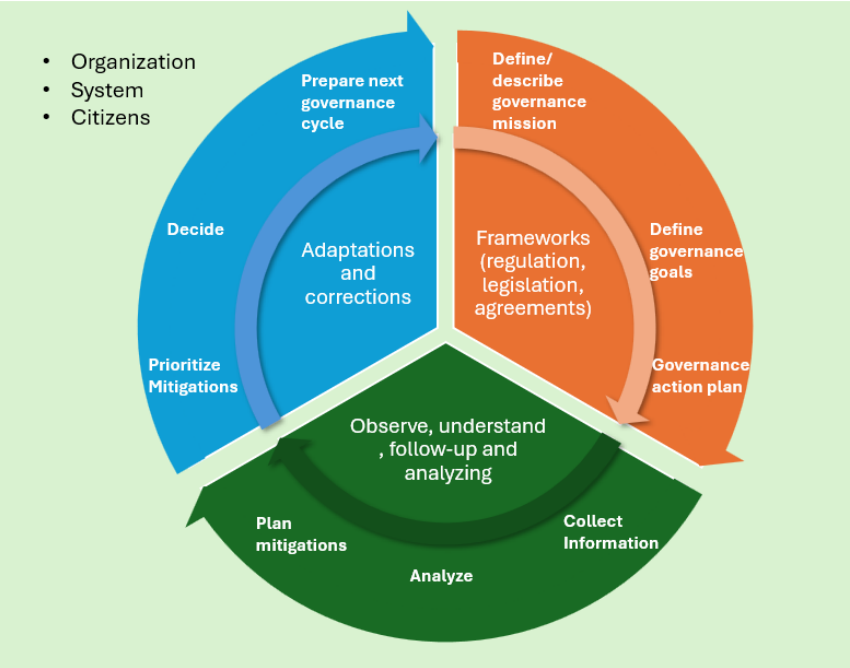
6. Governance to implement and sustain better, smarter, and intelligent regulation

As described in 'Section 5 - Better, smarter, and more intelligent regulations', the OECD clearly indicates that regulation and governance are intertwined concepts, while both concepts need to be brought into play to ensure a better, smarter, and more intelligent city. This section provides more detail on the governance perspective.

First, governance is a broad term that encompasses the structures, processes and mechanisms used to direct and manage collective activities. Governance encompasses both formal and informal arrangements that influence how public and private actors coordinate their actions, relationships, and resources.[11] Because Munich is a city, it needs to adopt a governance system that achieves different outcomes from those normally achieved by regular government. In Munich, the city, government agencies, private companies and civil society must interact to manage and solve collective problems. This means that governance needs to be extended to all types of organizations and social systems where there is a need for coordination and control to achieve desired goals and objectives.[12]

6.1. Three dimensions for a better, smarter, and more intelligent governance

Based on the Munich Mission, the following model was used to understand and describe the governance dimensions in the Munich Use Case. The dimensions can be validated from a citizen, organization and ecosystem dimension.



[11] Governance: An Interdisciplinary Perspective, P Zumbansen page 83-96.
[12] Nätverksstyrning som strategi för regional tucking? Josef Qaderi, 2013

Figure 1: Governance dimensions.

1. **Governance frameworks**
    a. Define and describe the governance mission: What is the purpose with spending time on governance in this initiative?
    b. Define governance goals: What goals are we going to achieve with governance of this initiative?
    c. Governance action plan: How are we going to achieve mission and goals: What do we need to do? How do we measure and understand that we are on right track to achieve governance mission and goals?

2. **Observe and understand**
    a. Collect data and information in line with the governance action plan.
    b. Analyze according to the governance action plan.
    c. Plan mitigations in line with the result from analyzing activities.

3. **Adapt and correct**
    a. Prioritize mitigation activities. This includes ensuring that correct stakeholders and are involved in understanding and prioritizing suggested mitigations.
    b. Decide on the most relevant and effective mitigations.
    c. Prepare for next governance cycle: As this type of governance needs to include double-loop learning[13]. Governance needs to be implemented as an iterative, cyclic process throughout the initiative as well as in future operations.

6.2 Governance from a Munich e-scooter case study

Examples of the Munich governance dimensions framework; observe and understand, adapt and correct as applied in the Munich use case:

Framework

Munich focused on practical applications of geofencing for specific case studies. The focus was on e-scooter parking and pedestrian safety. To create a governance action plan, Munich tailored its governance framework and contractual agreements to address its unique urban mobility challenges, leveraging technology and collaboration to improve safety and compliance. Governance objectives focused on understanding usage patterns, compliance rates and the impact on pedestrian safety and public order.

Munich used voluntary agreements with e-scooter providers to set rules for parking, data sharing and user compliance.

Observe and understand

Munich took a systematic approach to collecting, understanding and analyzing data, using technology and stakeholder engagement to improve its governance framework.

Munich also used geofencing technology and data sharing agreements with e-scooter providers to collect real-time data on e-scooter usage and parking.

[13] Double-loop Learning is a theory: Double-loop learning is a process used within organizations to understand and solve problems on a deeper level. When a mistake is corrected while also changing an organization's policy, values, and way of working, it is called double-loop learning (double-loop learning organization, C. Argyris, 1977)

For analysis and understanding, Munich relied on digital dashboards and stakeholder collaboration to interpret the data and identify usage patterns. The dashboard was used to continuously monitor e-scooter parking and movement patterns in real time. This provided ongoing insight into the effectiveness of the geofencing zones and compliance rates.

To ensure stakeholder collaboration, Munich held regular meetings with e-scooter providers to discuss data trends and emerging issues, ensuring that all parties were aligned and informed about the governance process. The city incorporated feedback from pedestrians and residents through surveys and public consultations. This feedback was used to refine the governance framework and address public concerns.

To ensure integration with regulation and policy, Munich conducted regular reviews of e-scooter regulations to ensure they remained relevant and effective. These reviews assessed the need for new regulations or changes to existing ones based on evolving data and stakeholder feedback.

Adapt and correct

To define and decide on mitigations and adjustments, Munich used a data-driven approach to geofenced zones based on real-time data and analytics. When certain areas showed high levels of non-compliance or safety concerns, the city adjusted geofencing parameters and enforcement strategies accordingly.

Munich adjusted geofenced zones and parking regulations based on the results of the risk assessment. If certain areas showed high levels of non-compliance or safety concerns, the city adjusted geofencing parameters and enforcement strategies accordingly.

6.2.1 Munich e-scooter case study governance challenges

Implementing governance in the transition from the current state to the future state naturally presents some challenges. To achieve better, smarter, and more intelligent governance, these challenges need to be addressed in the planning, execution and adaptation of the governance process. Examples of challenges in the Munich use case were:

- GPS accuracy, which sometimes resulted in e-scooters not accurately registering their position within geofenced zones.
- Data protection restrictions under GDPR, which made it difficult to share and use personal data to improve monitoring and enforcement.
- Regulatory hurdles included the need to continually update and adjust policies to keep them relevant and effective as new technologies and insights emerge.
- Voluntary agreements do not provide the city with a means of enforcement if e-scooter operators do not comply. On the other hand, voluntary agreements, combined with regular and structured dialogue, tend to engage ecosystems in a deeper sense and last longer than coercive regulation.

6.3 Summary and conclusion governance

The governance process needs to be updated based on continuous data analysis, stakeholder feedback and the observed effectiveness of current policies; other recommendations include.

- Use visualization as a tool in governance as an enabler, using digital dashboards for real-time monitoring of e-scooter parking and movement patterns to ensure compliance and the effectiveness of geofenced zones, strengthens the ability to conduct efficient governance.

- Mobilize and commit to governance: Regular meetings with e-scooter providers to discuss data trends and emerging issues are essential to ensure all parties are informed and working together effectively.
- Targeted data collection: Using collected data to adjust geofenced zones and regulations is critical, especially when adjusting geofencing parameters and enforcement strategies in areas of high non-compliance or safety concerns. In addition, incorporating feedback from pedestrians and residents through surveys and public consultations will help refine the governance framework and address public concerns.
- Conducting regular reviews of e-scooter regulations is also necessary to ensure they remain relevant and effective, assessing the need for new regulations or changes based on evolving data and stakeholder feedback.
- Regular consultation with transport operators and technology suppliers should be undertaken to interpret data and understand operational challenges to ensure all stakeholders are aligned. Gathering feedback from e-scooter riders to identify practical issues with the implementation of geofencing is critical, and this feedback should be used to refine the technology and its application.
- Implementing adaptive measures based on data analysis and feedback to improve compliance and safety is essential.

7. Learning from the e-scooter case study - experiences and evaluations

7.1 General conclusions

Geofencing is a useful tool for a regulator who wants to work with better, smarter, and more intelligent regulation. Geofencing allows regulators to collect data from a specific area and then set rules within that area. In the case of the e-scooter example, the technology and standard of communication is more or less the same across the EU, but within the EU what a city can regulate is different. In Sweden it is allowed for a city to regulate the speed of e-scooters, but the same is not allowed in Germany. This difference is important to keep in mind when sharing experiences between countries. What do countries and cities have in common and what is regulated at national level? It is not always possible to achieve regulatory coherence and coordination.

Geofencing is also a good starting point for a city to learn more about how to work with better, smarter, and more intelligent regulations. Regulators need to learn about the potential of information and data to increase productivity at the public decision-making level, following the experiences and examples of private initiative. This could include forecasting future trends and needs and developing alternative future scenarios. The Munich pilot project is a good example of a pilot project in which the authority, together with other stakeholders such as researchers, builds capacity and regulatory competence. Through the pilot, the city understood and managed emerging technologies and innovations.

Geofencing is also a good tool for dynamic and responsive regulation. A good example of this is how Munich, in case study B of the GeoSence pilot, introduced temporary rules for e-scooters during the Oktoberfest based on human behaviour. This was also a risk-based approach where the city identified human risk behaviour (drunk driving).

In general, a legislator can use a top-down or bottom-up approach. Which works best depends on the challenge being regulated. Top-down means that the regulator decides that this is the way it is, the change has a big impact immediately and the public has little opportunity to influence it. An example of this is changing the percentage in a paragraph for a tax, fee, or benefit. Button up is fundamentally about changing human behaviour. If people don't think the new rule is good, they won't change their behaviour, or they will change it slowly. In this way, the change has little impact and people can influence legislation through their own actions.
As mentioned in case study B of the pilot, Munich is working to change people's behaviour, namely where and how they park their scooters, and to discourage people from driving drunk at certain times. Normally this would be a bottom-up approach. But in the pilot, Munich is taking advantage of the fact that e-scooters can be programmed to control human behaviour (machine code is law). The city is also using data to understand the challenges. This is the kind of regulation more suited to a top-down approach.

Combining top-down and bottom-up perspectives creates new intersections. What is the relationship between the legislator and those directly and indirectly affected by the change? What is their relationship? What is the role of the city as a legislator in a democratically governed society?

7.2 How the city handled e-scooters

E-scooters were a new phenomenon for the city when they appeared in 2019. At the time, the city had no data about them. How and where to regulate e-scooters was somewhat of an emotional decision, based on angry residents and politicians complaining and demanding that something be done. The first regulation that was put in place, which was also voluntary, was therefore less evidence-based and therefore cannot be said to be in line with the concept of better regulation.

The next step was for the city to embark on an evidence-based process of better regulation. This required robust data. The data was in the hands of the e-scooter operators, but the city had no legal right to force them to give it to the city. Instead, data sharing had to be voluntary. Here the city did important and extensive work to build trust and commitment to data sharing, for example through stakeholder meetings (collaboration and stakeholder engagement). Munich also needed a platform to receive data from operators and invested money in this (capacity building).

In a second step, Munich moved to smarter regulation. Using data from operators and other data, the city was able to use the platform to start evaluating and determining the best location for new parking zones. The city also gained access to historical data from operators, allowing it to start the evaluation process more quickly. There are efficiencies for the city. Infrastructure is expensive to build. By having access to data, the city can see where the need for parking is and allocate resources where they are most needed. The city has not yet undertaken any deregulation, such as removing initial parking zones that were not based on evidence or moving parking zones due to changes in the behaviour of e-scooter users.

In a third step, the city also used the data and technical tools to enforce the rules. Although a voluntary self-commitment offers only limited possibilities, cooperation with the providers and compliance with the voluntary rules can generally be rated as good. Nevertheless, there are still problems, particularly with user behaviour, for which the responsibility of the providers is limited. GeoSence has shown that good regulation, based on valid data, always requires appropriate evaluation and monitoring. The best regulations are useless if no one is monitoring

compliance. Cities should also always ask themselves whether their regulations are up to date, and adapt them, if necessary, which would be a possible fourth step.

Munich hasn't yet reached the level of smart regulation in terms of using its own algorithms to analyse data, or combining data from other sources in the platform, or automatically geofencing to mobility service providers, but it sees the opportunities and knows it could ask new questions of the data. For example, identifying where access to public transport is low and where e-scooters could be an alternative. The market has not recognised and responded to this need. Smart regulation opens the door to greater efficiency. It may be most efficient for a private operator to be in the city centre, but it may be more efficient for society to have e-scooters elsewhere in the city. For example, some cities have publicly procured e-scooters to achieve greater efficiency for the society.

7.3 Lessons learned from the pilot

The platform has given the city access to large amounts of data, almost in real time. But in order to work with better, smarter, and more intelligent regulations in this case, it is not necessary to have access to large amounts of data in real time. The most important thing is that the city has access to the right data and good quality data. Over time, the city has collected less data from operators. The challenge is to identify what is the right data, how much is needed and what is the quality.

To work with better, smarter, and more intelligent regulations, the city needs to work on improving the skills of its staff. They need education and training in digital systems design and development skills and data use. It may also be necessary to recruit staff with new skills to maximise the benefits.

Better regulation is about engaging the different stakeholders who are directly and indirectly affected by regulation. They need to have confidence in the process and the outcome. There must be clear processes for collecting data and implementing regulatory changes (transparency and accountability), based on the following common parts of data governance:

- Qualification - How, when, where, from whom and of what quality should the data be requested?
- Contracting - Data sharing needs to be planned and contracted.
- Execution - How will the data be delivered?
- Feedback and evaluation - How can the process be improved?

Those directly affected by the city's data collection are the operators. In this part, the city is completely dependent on them wanting to share data voluntarily, otherwise the city cannot access the data. This makes the data collection vulnerable. What happens if the city pays for and builds a regulatory change process based on data sharing, but then the operators decide to stop sharing data or say they want to be paid for data? In the longer term, this type of arrangement may need to be legislated.

The way the city communicates with the operators is through the platform. The platform itself needs to be developed in-house or procured and funded. The platform also needs to be open to change, such as changes in technology, new ways of collecting data or changes in human behaviour. The city has not yet exploited the full potential of a platform to enable two-way communication, such as machine-readable legislation. Today, the city communicates new regulations to the operator via email.

Smart regulation also aims to reduce administration and make it easier and simpler for businesses. There is a risk that the platform will allow the city to constantly monitor and make small changes (micromanagement), which can lead to increased administration and costs for operators. In many cities, e-scooters are a free market. It is important to find the right level of micromanagement. What is proportionate? How often should a scheme change, once a year, twice a year, every month, etc? What gives the city enough flexibility without annoying the operators? From the operators' point of view, there is a risk that the scheme will not meet the requirements of simplification and burden reduction.

In better, smarter, and more intelligent regulation, it is important to have a transparent and open process that allows for public consultation and participation. Stakeholders should have access to information and be able to contribute to regulatory decision-making. Policies should also be developed on the basis of rigorous evidence and analysis, including regulatory impact assessments to assess the potential effects of proposed regulations. The big challenge for this type of solution in the future will probably be to get the commitment of those who are indirectly affected by the data collection but directly affected by the regulation, namely those who use e-scooters. This type of data collection allows for quick rule changes, whereas rulemaking has been a relatively slow process where citizens have been invited to participate through open dialogue. How will the city present the results of data collection and proposals for new rules so that they can be scrutinised by citizens? Will citizens have the skills to understand and interpret the data being collected, or will it be a black box of regulations? How will citizens' feelings about a particular phenomenon be taken into account in a data-driven process of regulatory change? The city has not yet explored this issue. Remember that fostering the interface with stakeholders also means supporting citizens' "right to know" by applying open government principles and tools and good administrative practices.

Better, smarter and more intelligent regulation is also about evaluation and continuous improvement. One outcome of the Munich use case could be a four-step approach to managing e-scooters in the city to ensure road safety, a good user experience and cooperation with mobility service providers. The first step is to use good data to monitor and understand how e-scooters are being used in the city. Based on these findings, targeted rules are created and sent digitally to the mobility service providers. These rules, in turn, need to be monitored for compliance by the rule maker. Digital tools that can support this are best suited for this purpose. However, this can only happen if the necessary capacity is available for this step. In the final step, the existing rules need to be changed and, if necessary, adapted. This is where the quadrilogy starts again.

It is also important to involve all stakeholders. In Munich, for example, despite voluntary cooperation, it was possible to define the old town with its 43 parking zones as a no-parking zone, and this regulation has been in place ever since. This requires cooperation between mobility service providers and cities. If there is poor cooperation, parking problems or road safety issues, the result could be a ban on e-scooters, as some cities have done after allowing them for a while, such as Paris. If Munich chooses to make such a decision in the future, it will need to consider the lessons learned from the geofencing of e-scooters. Learning from both successes and failures helps to refine regulatory approaches.

In conclusion, geofencing is a good tool for better, smarter, and more intelligent regulation.

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